Architecture Analysis Research Project Status

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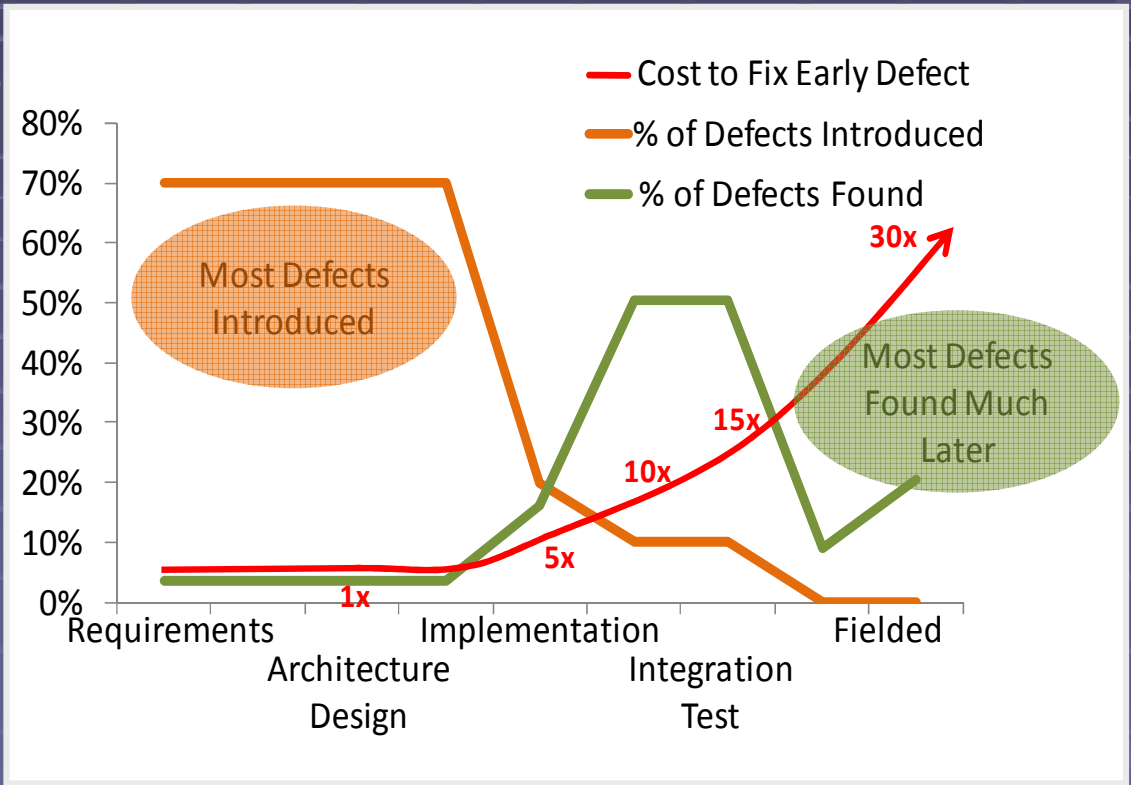
Overview

- Architecture IV&V
- Architecture Analysis Research Elements
  - Architecture Perspectives
    - Topics for analytical investigation
    - Views for improving architecture specifications
  - Architecture Analysis Framework
    - Tailorable set of architecture analysis objectives
    - Methods for accomplishing objectives

Impact of Architecture Phase IV&V

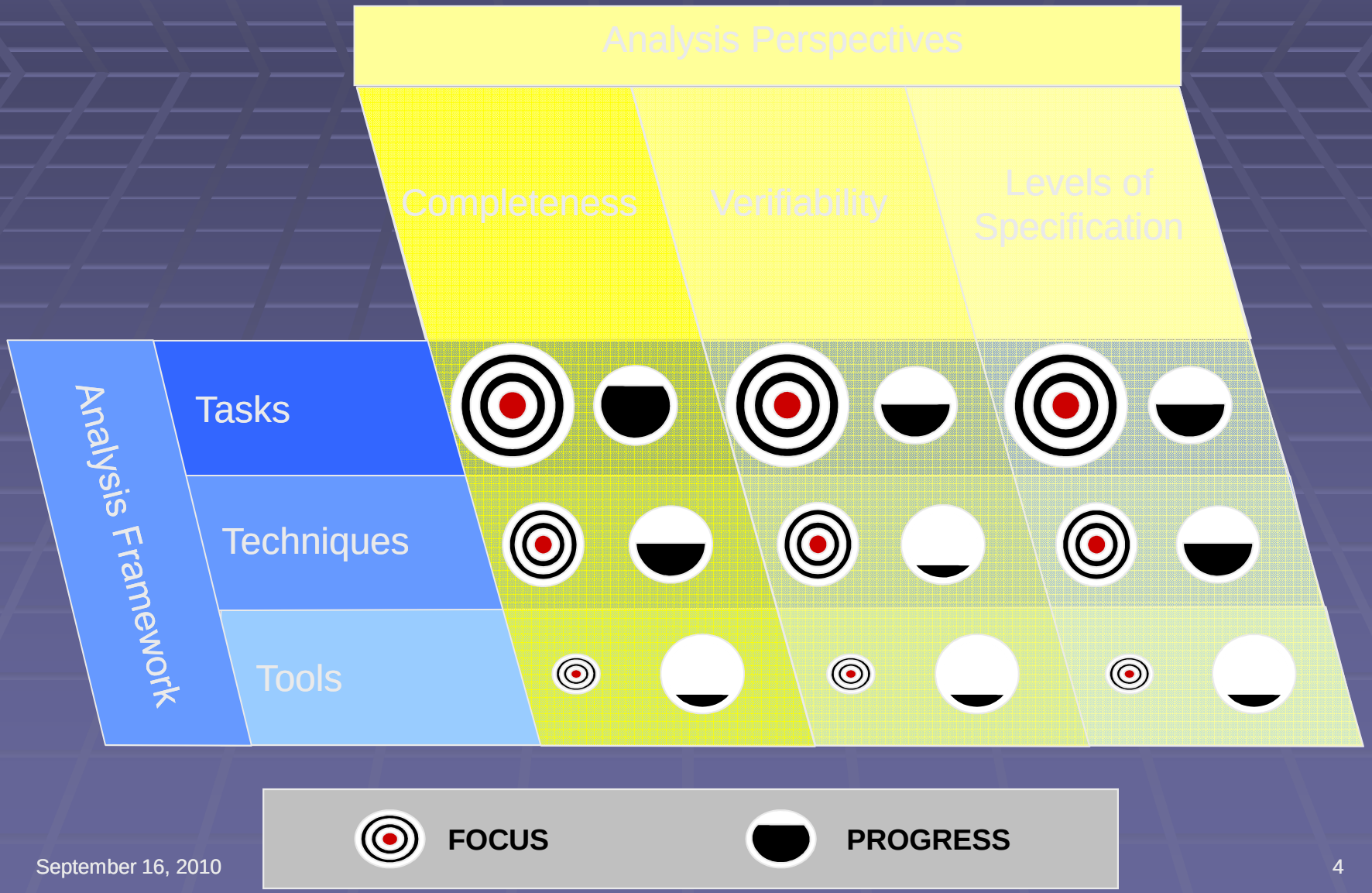
- Architectural issues are a leading source for integration problems
- Without systematic upfront analysis these problems are costly to repair
- Application of complexity, safety and dependability analysis enables addressing the issues early on
- Architectural decisions impact what is required of the software



Source: NIST Planning report 02-3, *"The Economic Impacts of Inadequate Infrastructure for Software Testing"*, May 2002.

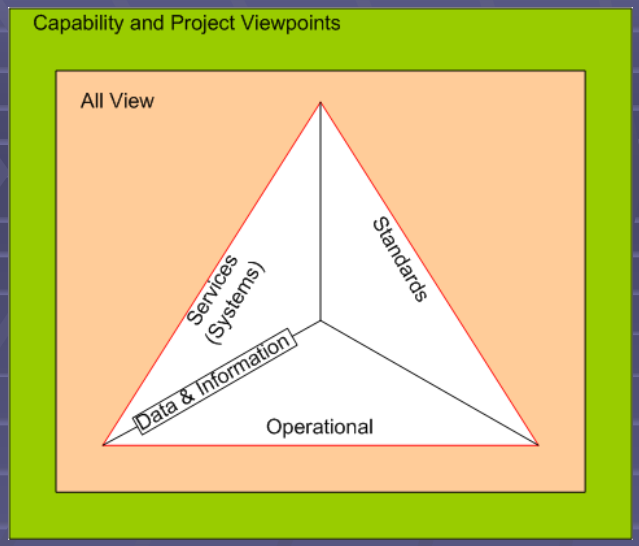
- Improved architecture specifications reduce software risk and increase IV&V's ability to validate and verify the software

Architecture Analysis Research Elements



Frameworks

DoDAF 2.0



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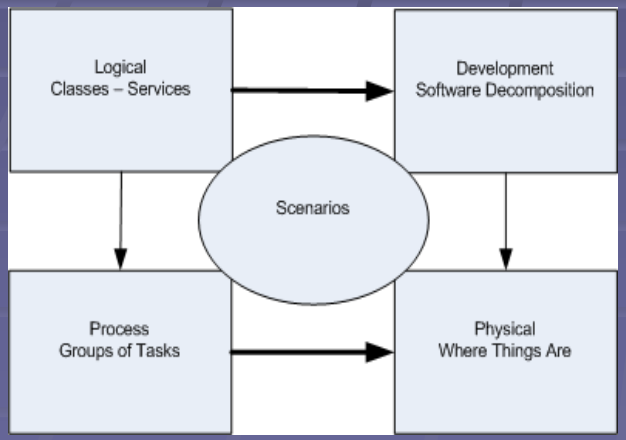
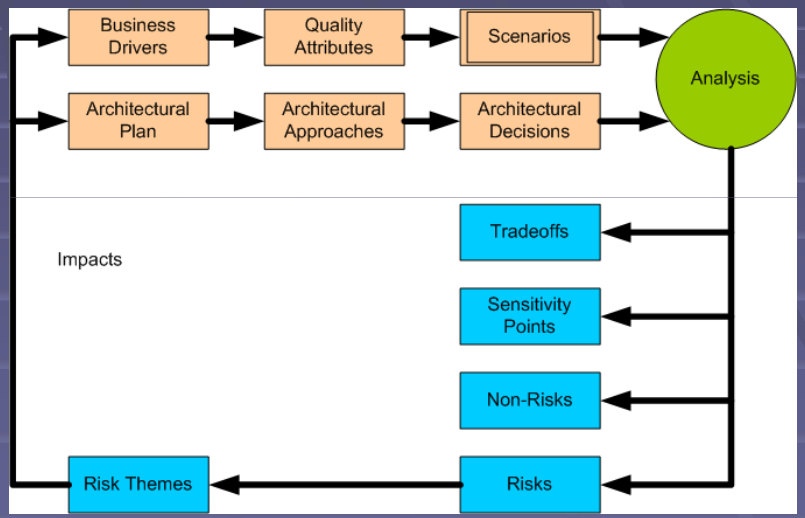


ATAM



Evaluation

Representation

DoDAF Views included in CSADD

View	Section	Comments
OV-2	3.1.1	▪ Operational resource flow description ▪ Not complete in current version ▪ Map to operational scenarios (also not complete) ▪ Hierarchical or mission phase views
OV-3	3.2	▪ Operational resource flow matrix ▪ Decomposed by mission phase and needline type ▪ Limitations of OV-2 make OV-3 completeness assessment difficult ▪ Many TBD
OV-5	3.4	▪ Operational activity model ▪ Presented via activity diagrams and flowcharts ▪ Some activities (e.g. build process) missing OV-3 antecedent ▪ IDEF0 notation is recommended due to more complete activity description ▪ More complete set of scenarios recommended
SV-1	4.1	▪ System interface description ▪ Systems and interfaces to realize OV-2 ▪ Levels of specification management in CSADD could be improved
SV-2	4.2	▪ Systems communication description ▪ CSADD will require more detail
SV-6	4.3	▪ Systems data exchange matrix ▪ Tabular characterization of data form SV-1 and SV-2 ▪ CSADD contains abridged SV-6

CSADD Tailoring Analysis

- CSADD based on DoDAF 1.0
- Some sections explicitly mapped to DoDAF
- Tailored-out views which would help
  - AV-1 Executive Summary
  - AV-2 Integrated dictionary (partially tailored)
  - OV-6 Operational activity sequence & timing
    - Significant weakness
  - SV-4 Systems functionality description
    - Systems version of OV-5

CSADD Compliance with DoDAF 2.0

- Activities replace operational nodes – impacts operational viewpoints
- More hierarchical OV-2 would facilitate traceability analysis
- Adoption of service-oriented approach (SvcV replacing SV) recommended
- Used emergency voice as test case
  - Generally, not enough detail provided
  - Example: emergency voice software not differentiated from primary voice

Verifiability

- Features of the architecture are mapped to requirements, which are then mapped to the verification tests that verify them
  - All components have requirements that are tested
  - All component interfaces have specified requirements that are mapped to verification tests
  - All critical scenarios coverable/covered by test cases
- Technical budgets, budget allocations, and compliance to budgets expressed in observable/measurable terms
- Risks noted for untestable capabilities, services, interactions, and scenarios and a risk mitigation approach using simulation and analysis planned

Managing Levels of Specification

- This perspective is concerned with managing
  - Properties of a system as a whole
  - Properties that are allocated to the parts from which it is composed
- Document descriptions are information subsets (i.e. abstractions) that need to fit in an organized hierarchy
- Assessing levels of specification can:
  - Detect misalignment of levels of specifications (e.g. semantics)
  - Gaps in interfacing stakeholder/developer abstractions (e.g. omissions)
  - Potential system integration issues (e.g. pattern errors)

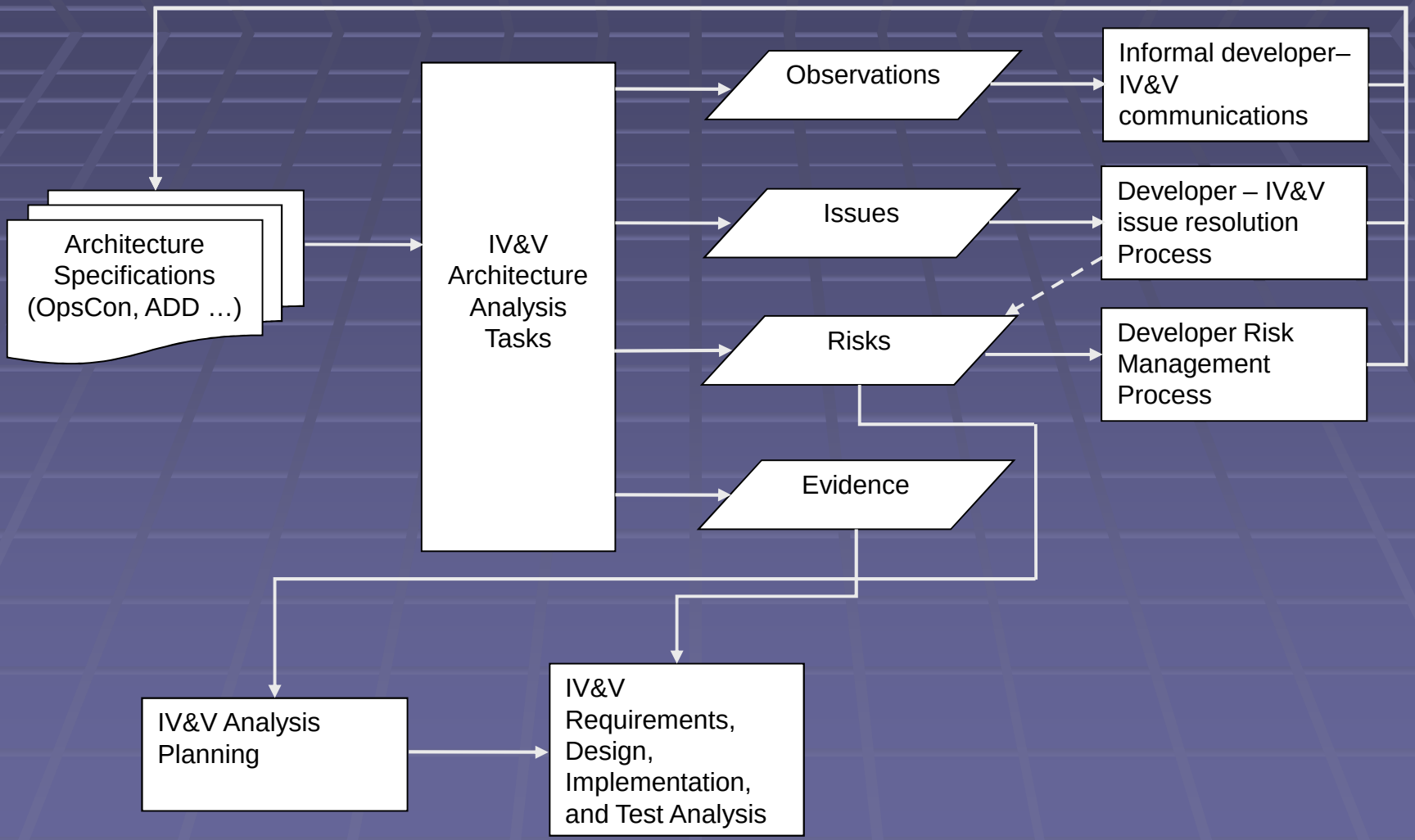
Levels of Specification and Multiple Objectives

- The primary objectives of a system should leave many degrees of freedom for design open
  - Detect stakeholder biases that introduce artificial constraints on downstream tradeoffs
    - Requirements that bias the problem space
    - Implementations that bias the solution space
- Downstream options are then eliminated on the basis of the secondary objectives of the work system
- In many systems, the primary objectives, secondary objectives, and external constraints are often conflicting
- Objectives, like safety or fault tolerance, can have conflicting implementations (e.g. “do nothing” may be safest!)

Levels of Specification and Safety Example

- When objectives, like safety or fault tolerance, have conflicting implications it was unclear in the CSADD how conflicts were resolved
- There is a risk that system level requirements like safety may merely be specified as measures of goodness at a component level
- Need to determine if interpretation of safety is consistent at different levels of specification and among system stakeholders
- Need to determine if an implementation can compromise a critical objective when mixed with other factors (either critical/non-critical)
  - E.g. scheduling of critical communications over a shared network or writing to a shared database

Architecture Analysis Context



IV&V Architecture Analysis Tasks

Completeness

- Specification completeness
- Functional Capability Mapping
- Dependency mapping analysis
- Technical budgets analysis
- Top-level requirements mapping
- Scenario development
- Fault management and redundancy analysis

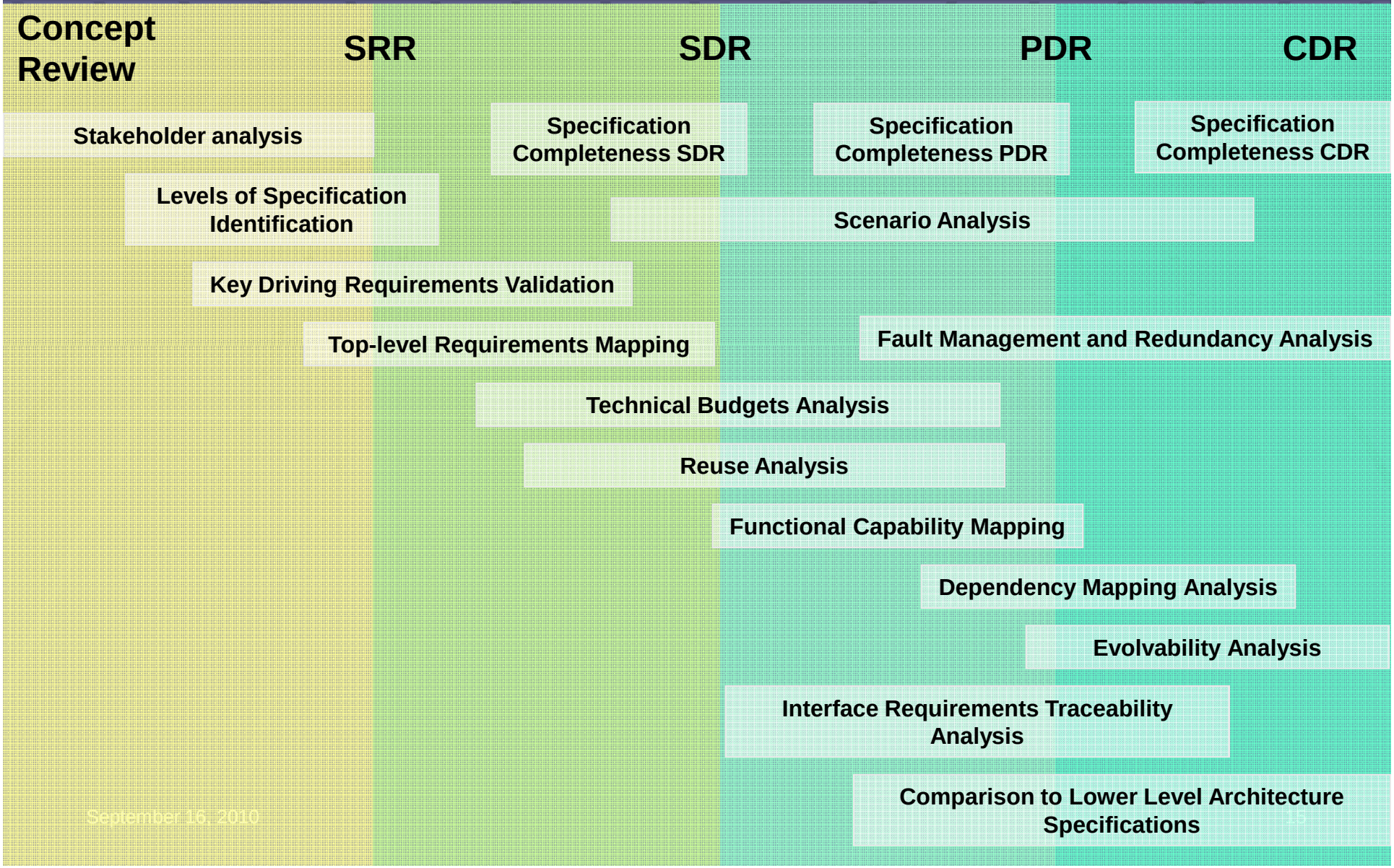
Verifiability

- Reuse Analysis
- Interface requirements traceability analysis
- Key driving requirements validation

Levels of Specification

- Levels of specification identification
- Stakeholder analysis
- Evolvability analysis
- Comparison to lower level architecture specifications

Task Phasing

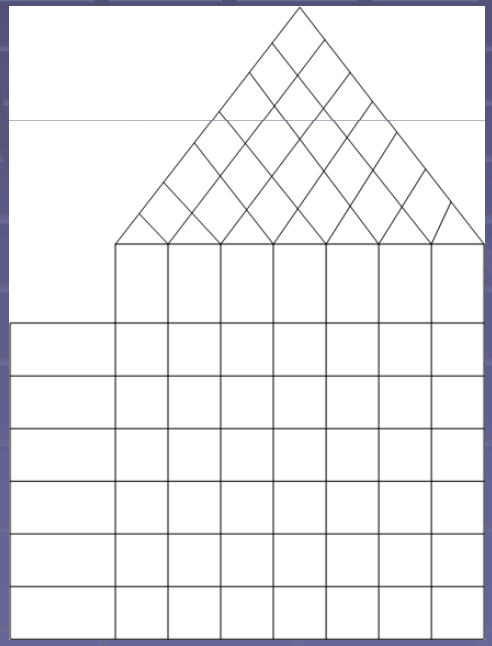


IV&V Techniques

- Specification Completeness
  - DoDAF content checklists
- Levels of Specification Identification
  - Keyword and phrase pattern search vertically through document tree
- Scenario analysis
  - Scenario modeling, and simulation and test
- Fault Management and Redundancy Analysis
  - Error propagation analysis and containment
  - Coupling analysis
- Technical budgets Analysis
  - Budget identification from ADD and document tree
  - Analyze budget allocation, feasibility
- Mapping Tasks (Functional Capability Mapping, Dependency Mapping Analysis, I/F Requirements Traceability Analysis, Top-level Requirements Mapping)
  - Quality function deployment (QFD) matrix

Tool Support Opportunities

- Smart keyword search
- Budget mapping tool
- Scenario visualization and testing
- Tracing tools (implement QFD House of Quality)



Architecture Analysis Tailoring

- Involves selecting project-applicable tasks
- Guided by project manager's tailoring goals
  - Breadth vs. depth
  - Comprehensive vs. limited
- Driven by many factors
  - Overall system criticality and risk
  - Architecture style (DoDAF, 4+1, etc)
  - Mission type/System type
  - Development approach
  - Development phase
  - Artifact availability and maturity
  - Task dependencies

Summary

- Architecture IV&V essential
- CSADD-inspired ADD improvements
  - Completeness
  - Verifiability
  - Levels of abstraction
- IV&V architecture methodologies
  - Ideal task set covers all aspects of architecture
  - Techniques achieve tasks
  - Tools facilitate and automate techniques